Natural Gas Line Sizing using General Pressure Drop Equation

May 19, 2017 (https://missrifka.com/gas-processing-plant/natural-gas-line-sizing-using-general-pressure-drop-equation.html) Rifka Aisyah (https://missrifka.com/author/rifka) Gas Processing Plant (https://missrifka.com/./gas-processing-plant)

Line sizing is a part of every engineering activity. Although it is not major part, line sizing is required when we prepare piping and instrumentation diagram. In this post, I want to share you how to do **natural gas line sizing** (actually the method is applicable for all kind of gases).

I usually use process simulator when it came to natural gas line sizing. Long time ago, I tried to size manually. But the result is not the same as from simulator. But, I tried again and yesterday I got a satisfied results.

Natural gas line sizing calculated in this post will be from **manual calculation** and from **process simulator**. API RP 14E is used as reference.

Based on API RP 14E, single-phase gas lines should be sized so that the resulting end pressure is high enough to satisfy the requirements of the next piece of equipment. So, the point is the end pressure. The velocity is also a noise problem if it exceeds 60 ft/s. However the velocity of 60 ft/s should not be

interpreted as an absolute criteria. Higher velocities are acceptable when pipe routing, valve choice and placement are done to minimize or isolate noise.

API RP 14E mentioned several approach to calculate pressure drop, but in this post I will use **general pressure drop equation.**

The idea of this line sizing is: **to guess pipe ID until it met end pressure criteria**. We will use spreadsheet to goal seek the equation. It is really simple and easy.

General Pressure Drop Equation

This is general pressure drop equation:

$$P_1^2 - P_2^2 = 25.2 \frac{SQ_g^2 ZT_1 fL}{d^5}$$

Where:

P_1	= upstream pressure, psia
P_2	= downstream pressure, psia
S	= gas specific gravity at standard conditions
Q_g	= gas flow rate, MMscfd (at 14.7 psia and 60°F)
Z	= compressibility factor for gas
T_1	= flowing temperature, oR
f	= Moody friction factor, dimensionless
d	= pipe ID, in
L	= length, ft

Rearranging the equation, we have:

$$Q_g = 0.199 \left[\frac{d^5 (P_1^2 - P_2^2)}{ZT_1 LS}\right]^{1/2}$$

(https://missrifka.com/calculation/natural-gas-line-sizing-using-general-pressure-drop-equation.html/attachment/general-pressure-drop-equation-for-natural-gas-line-sizing)

General pressure drop equation for natural gas line sizing based on API RP 14E

The key to get correct results by using this equation is to prepare all correct data. Last time I put wrong data for gas specific gravity at standard condition, so that the results is different from I got from simulator.

I used Norsok standard as pressure drop criteria in single-phase line sizing. You can use your own standard or you can **determine the value of end pressure (P2) by yourself** which is high enough to satisfy next equipment as mentioned in API RP 14E.

Example: Natural Gas Line Sizing by using P2 as Criteria

This is an example. I have gas with the following properties. I used Norsok to determine the value of acceptable P2. So that, I have collected all data I need to line size.

Data			
Qg	Gas flow rate	MMscfd	*0,4008*
Wh	Mass flow rate	lb/h	*800,1*
P1	Upstream pressure	psia	*43,7*
	Allowable pressure drop (Norsok)	psi	*1,595*
		bar	*0,1100*
P2	Downstream pressure	psia	*42,10*
Z	Gas compressibility factor		*0,9919*
T1	Flowing temperature	deg R	*546*
L	Pipe length	ft	*328,1*
ρ gas, std	Density of gas at standard condition	lb/ft3	*0,096*
ρ air, std	Density of air at standard condition	lb/ft3	*0,152*
ρ gas, P1, T1	Density of gas at P1 and T1	lb/ft3	*0,1365*
μ		cP	*0,011*
ε	Roughness	mm	*4,5E-02*
ε/D	Relative roughness		*7,6E-04*

(https://missrifka.com/calculation/natural-gas-line-sizing-using-general-pressure-drop-equation.html/attachment/data-for-natural-gas-line-sizing)

Data for natural gas line sizing

By using **second equation**, I **guessed** value of **pipe ID (d, in inch)** so that I have **calculated flow rate is the same as target flow rate**, which is 0.4008 MMscfd. I got **pipe ID = 2.32 in**. The nearest value is **2.47 in (NPS 2.5 in)**. At this pipe ID, gas velocity is **55.54 ft/s**, which is almost close to standard mentioned in API RP 14E. The pressure drop is **1.595 psi**.

By using process simulator and the same pipe ID, this is the results I got:

- Gas velocity = 55.44 ft/s
- Pressure drop = 1.591 psi

The results are the same! Congratulations everyone.

Example: Natural Gas Line Sizing by using Velocity as Criteria

Example above shows that the velocity is too high. We want to reduce the velocity to about **30 ft/s**, for example. Thus we have to increase pipe ID. Let say **pipe ID = 3 in**. Then we got :

- Gas velocity = **33.18 ft/s**
- End pressure = **43.27 psia**, or **pressure drop = 0.43 psi (use equation 1)**

By using process simulator we got:

- Gas velocity = **34.18 ft/s**
- End pressure = **43.28 psia**, or **pressure drop = 0.426 psi**

The result is similar too.

BONUS!

This is a spreadsheet I used to calculate line size of gas manually. All the results above are got from this spreadsheet. I hope you find it useful. If you feel confuse, do not hesitate me to contact me.

Reference: API RP 14E

[button style="btn-default btn-sm" icon="glyphicon glyphicon-save" align="left" iconcolor="#4285bf" type="link" target="false" title="Download Natural Gas Line Sizing" link="https://missrifka.com/?attachment_id=2034"]

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8 thoughts to "Natural Gas Line Sizing using General Pressure Drop Equation"

DEDE

December 12, 2019 at 1:42 pm (https://missrifka.com/gas-processing-plant/natural-gas-line-sizing-using-general-pressure-drop-equation.html#comment-2798)

where is the spreadsheet of gas line sizing ?

I can't donwload it

REPLY

RIFKA AISYAH (HTTPS://MISSRIFKA.COM)

December 17, 2019 at 2:36 pm (https://missrifka.com/gas-processing-plant/natural-gas-line-sizing-using-general-pressure-drop-equation.html#comment-2799)

Hi Dede, you can download the spreadsheet via the link at the end of the post

REPLY

DENNIS ADAMS

September 1, 2021 at 1:51 pm (https://missrifka.com/gas-processing-plant/natural-gas-line-sizing-using-general-pressure-drop-equation.html#comment-2842)

Check your density values for air and gas at standard conditions.

Air =+/- 0.072 lb/ft3

Nat Gas =+/- 0.044 lbs/ft3

REPLY

NICOLAS (HTTP:WWW.LU464.ORG)

February 10, 2022 at 3:07 am (https://missrifka.com/gas-processing-plant/natural-gas-line-sizing-using-general-pressure-drop-equation.html#comment-2877)

I teach “longest length” method to HVACR apprentices. For years I have not had a clear answer regarding when to use which table in the fuel gas code books. Specifically because of pressure drop. I can explain pressure drop to them just like I do when I teach on Hydronics. Looking for help in when to use a 1 psi drop table vs a 2 psi drop table? These students will more than likely not be sizing gas lines for new projects, but as a tech it is good info to know so we can see if our shortage of gas is due to line sizing.
Thank you very much for your help,

REPLY

RAKESH R PATIL

September 22, 2022 at 10:38 am (https://missrifka.com/gas-processing-plant/natural-gas-line-sizing-using-general-pressure-drop-equation.html#comment-2915)

Hi Sir,

Is this standard applicable for offshore or it can be used for other cases also (like indoor, or in any Indian outdoor conditions , onshore etc..)

REPLY

RIFKA AISYAH (HTTPS://MISSRIFKA.COM)

September 22, 2022 at 1:30 pm (https://missrifka.com/gas-processing-plant/natural-gas-line-sizing-using-general-pressure-drop-equation.html#comment-2916)

Hi Rakesh,

In my experience, my clients approved when API 14E is used for offshore or onshore application.

REPLY

RAKESH R PATIL

September 22, 2022 at 3:07 pm (https://missrifka.com/gas-processing-plant/natural-gas-line-sizing-using-general-pressure-drop-equation.html#comment-2917)

Can i get your mail ID ? (If you don't mind)
you can dm to my mail directly
I have few questions to ask
Thanks for the wonderful blog
All the best

REPLY

RAKESH R PATIL

September 23, 2022 at 10:37 am (https://missrifka.com/gas-processing-plant/natural-gas-line-sizing-using-general-pressure-drop-equation.html#comment-2918)

Let me know if you have spreadsheet in metric unit system

REPLY

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